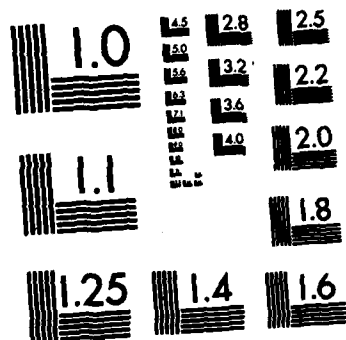END

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MICROCOPY RESOLUTION TEST CHART
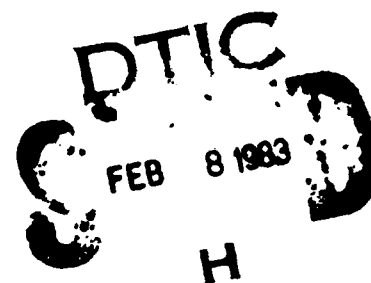NATIONAL BUREAU OF STANDARDS-1963-A

ESL-TR-82-30

(12)

SURVEY OF JP-4 VAPOR INCINERATOR AT ELLINGTON AFB, TEXAS

RICK KRENZKE

ENGINEERING-SCIENCE
3109 N. INTERREGIONAL
AUSTIN, TX 78722

OCTOBER 1982

FINAL REPORT
JUNE 1982 - AUGUST 1982

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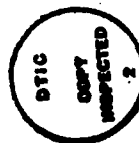SHOULD DIRECT REQUESTS FOR COPIES OF THIS REPORT TO:

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Incineration	Emission Control	Pollution Control
Jet Fuel	Air Pollution	
Vapor Control	JP-4 Emissions	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

During the incinerator emission test program, eight loading operations were observed and tested. Five truck loadings and three tank transfers occurred during the test period. Mass emission rates for NO_x, CO, and total hydrocarbons (THC) were determined and found to be well below all national standards for similar processes. Combustion efficiencies from these eight events ranged from 99.67 to 99.84% and destruction efficiencies ranged from 95.9 to 99.5%. Outlet concentrations of NO_x, O_2, CO, CO_2, and THC were

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monitored continuously. Inlet hydrocarbon samples were collected in bags and analyzed onsite on a gas chromatograph equipped with a flame ionization detector.

SUMMARY

During the emission test program, conducted June 2 - 3, 1982, eight events, or loading operations, were observed and tested (Table 1). Five truck loadings and three tank transfers occurred during the test period. A list of the truck loading events is found in Table 2. Mass emission rates of NO_x, CO, and THC were determined and found to be well below AP-42 standards for similar processes (Table 4 and 5). Combustion efficiencies from these eight events ranged from 99.67 to 99.84 percent (Table 3). Destruction efficiencies ranged from 95.9 to 99.5 percent. Outlet concentrations of NO_x, O_2, CO, CO_2, and THC were monitored continuously. Inlet hydrocarbon samples were collected in bags and analyzed onsite on a gas chromatograph equipped with a flame ionization detector (G.C. - FID).

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TABLE 1
ELLINGTON AFB JP-4 INCINERATOR TEST
SEQUENCE OF EVENTS

Time	Description	Test Event Designation
June 2, 1982		
0801	Start incinerator warmup	
0806	Start loading truck A	#1
0820	Stop loading truck A	
0823	Start loading truck B	
0835	Start loading truck C	#2
0837	Stop loading truck B	
0838	Continue loading truck C	#3
0847	Stop loading truck C	
0853	Stop incinerator warmup	
1203	Start incinerator warmup	
1207	Start transfer to tank A	#4
1300	Start transfer to tank B	
1300	Continue transfers to both tanks A and B	#5
1308	Incinerator overload, stop transfers	
1312	Restart transfer to tank A	
1320	Stop transfer to tank A	
1325	Start transfer to tank B	#6
1426	Stop transfer to tank B	
June 3, 1982		
0806	Start warmup of incinerator	
0809	Start simultaneous loading of trucks D and E	
0817	Stop loading truck D	
0818	Start loading truck F	#7
0828	Stop loading truck E	
0834	Stop loading truck F	
0839	Start simultaneous loading trucks G and H	
0853	Stop loading truck G	#8
0859	Stop loading truck H	

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TABLE 2
TRUCK LOADING EVENTS*

Event	Truck(s)	Loading Time (minutes)	Gallons Loaded	Supplemental Natural Gas (ft^3)
1	A	14:01	4,131	
2**	B	15:03	4,366	1,074
3	C	11:16	3,281	
7	D	08:38	2,086	
	E	19:17	4,550	
	F	16:15	4,108	1,187
8	G	14:04	3,403	
	H	18:30	4,400	

*Pressure relief valves on trucks were observed to open during the loadings. Therefore, an undetermined fraction of the total JP-4 vapors vented from the trucks were received by the incinerator. The remainder of the JP-4 vapors were vented to the atmosphere.

**Two trucks were loading simultaneously during the last 3-minute period of Event #2 (trucks B and C).

TABLE 3

ELLINGTON AFB JP-4 INCINERATOR
AVERAGE POLLUTANT CONCENTRATIONS AND PERCENT COMBUSTION EFFICIENCY

Event Number	Date	Time	Average NO_x Concentration (ppm)	Average O_2 Concentration (%)	Average CO Concentration (ppm)	Average CO_2 Concentration (%)	Average THC Concentration (ppm as CH_4)	Percent Combustion Efficiency
I	6-2-82	0806-0827	10.0	18.6	23.5	1.8	34.7	99.67
II	6-2-82	0823-0838	14.0	17.9	20.0	2.0	26.6	99.77
III	6-2-82	0838-0847	15.3	17.1	18.3	2.0	20.6	99.81
IV	6-2-82	1203-1300	16.0	16.8	27.1	2.1	13.3	99.80
V	6-2-82	1300-1308	23.3	16.0	20.0	1.9	10.5	99.84
VI	6-2-82	1325-1426	17.5	16.9	20.0	2.0	11.9	99.84
VII	6-3-82	0809-0834	10.1	17.9	35.0	2.0	16.4	99.74
VIII	6-3-82	0839-0859	12.6	17.9	25.0	2.2	12.7	99.83

Combustion Efficiency Calculation:

$$\frac{[CO_2]}{[CO_2]+[CO]+[THC]} \times 100 = \% \ CE$$

TABLE 4

JP-4 INCINERATOR TEST
ELLINGTON AIR FORCE BASE
NO_x AND CO MASS EMISSION RATES

Event Number	Emission Flow Rate (ft^3/min)	NO_x		CO	
		Concentration (ppm)	Mass Flow (lbs/hr)	Concentration (ppm)	Mass Flow (lbs/hr)
1	9,900	10.0	0.51	23.5	1.02
2	9,900	14.0	0.72	20.0	0.86
3	9,900	15.3	0.78	18.3	0.79
4	9,900	16.0	0.82	27.1	1.17
5	9,900	23.3	1.19	20.0	0.86
6	9,900	17.5	0.90	20.0	0.86
7	9,900	10.1	0.52	35.0	1.51
8	9,900	12.6	0.65	25.0	1.08

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TABLE 5

JP-4 INCINERATOR TESTS
ELLINGTON AIR FORCE BASE

Event Number	Duration of Event (minutes)	Inlet HC					Outlet HC		
		Volume Displaced (gallons)	(ft^3)	HC Concentration (ppm$_v$)	HC Mass Flow Rate (lbs/hr)	Emission Flow Rate (ft^3/min)	HC Concentration (ppm$_v$)	HC Mass Emission Rate (lbs/hr)	HC Destruction Efficiency
1	14.0	4,131	642	174,400	20.22	9,900	34.7	0.87	95.9%
2	15.1	4,366	679	N/A	N/A	9,900	26.6	0.66	N/A**
3	11.3	3,281	510	N/A	N/A	9,900	20.6	0.51	N/A**
4	53	21,730	3,379	308,000	50.88	9,900	13.3	0.33	99.3%
5	8	6,560	1,020	N/A	N/A	9,900	10.5	0.26	N/A***
6	61	25,610	3,889	211,200	34.10	9,900	11.9	0.29	99.1%
7	18.5	10,744	1,671	368,000	84.19	9,900	16.4	0.41	99.5%'
S	19.3	7,563	1,213	324,000	51.54	9,900	12.7	0.32	99.4%

*Values expressed on methane basis; multiply times 0.25 for conversion to JP-4 basis.

**Samples lost due to equipment malfunction.

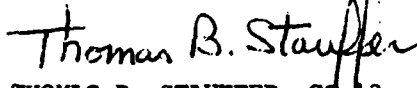***No sample taken during this short event.

PREFACE

The JP-4 vapor incinerator test program was conducted by Engineering-Science, Inc., 3109 N. Interregional, Austin. TX 78722, under Air Force Contract No. F33615-80-D-40001, for the Air Force Engineering and Services Center, Air Force Engineering and Services Laboratory, Tyndall AFB, Florida. The work was done at Ellington AFB, TX. Capt. Charles Andrle of Ellington AFB acted as the onsite coordinator and assisted the test crew by providing personnel and equipment as necessary to support the test program.

This report summarizes work done between June and August 1982. Mr. Thomas B. Stauffer was AFESC Project Officer.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

THOMAS B. STAUFFER, GS-13
Research Chemist

FRANCIS B. CROWLEY III, Col, USAF
Director, Engineering and Services
Laboratory

MICHAEL J. RYAN, Lt Col, USAF, BSC
Chief, Environics Division

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TABLE OF CONTENTS

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SECTION 1

INTRODUCTION

The source that was tested was a jet fuel (JP-4) vapor incinerator located at Ellington Air Force Base, Texas. A direct flame incinerator system is used to control organic vapor emissions resulting from bulk transfer and tank filling of JP-4 fuels.

The primary test objective was to determine the incinerator destruction efficiency of JP-4 vapors by obtaining the inlet and outlet hydrocarbon concentrations and mass emission rates. Samples of uncombusted vapor were analyzed to determine incinerator efficiency. Since the incinerator was fired on natural gas to ensure fast combustion and maintain adequate temperatures during operations, it was necessary to measure the source's hydrocarbon background emissions caused by this gas firing.

Concentrations of oxides of nitrogen (NO_x), oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), and a volumetric flow rate were determined at the stack outlet ports.

The field testing was conducted by Marc McDaniel, Rick Krenzke and Kirk Hunter of Engineering-Science, Austin Air Quality office. Mr. Thomas Stauffer from AFESC/RDVC, Tyndall AFB, Florida, witnessed the test program conducted June 1-3, 1982.

SECTION 2

SYSTEM DESCRIPTION

The JP-4 vapor emissions occur due to the filling operation involving two fixed-roof, 32,000 gallon, work tanks from a larger floating-roof storage tank and the filling of the jet refueling trucks from the work tanks. The JP-4 vapors are diverted to the incinerator, which operates when one or both types of filling operations are in progress. A schematic of the operational hardware can be found in Figure 1. Pressure in the vapor line activates a switch which ignites the incinerator for natural gas preheating. When the temperature in the primary combustion zone reaches 1200°F, a hermetic booster starts up, which induces JP-4 vapor flow through a water separator, a flame arrestor and into the incinerator combustion zone. After a brief period (about 2 minutes), the pressure decreases in the vapor inlet line and activates a cutoff, which shuts down the incinerator for about 30 seconds. Natural gas preheating proceeds briefly upon restart, followed by vapor incineration, cutoff, etc., repeating this cycle until the filling operation or loading event is completed.

Due to this cyclic operation, emissions are variable through the continuous loading operation. This can be observed on the example strip charts found in Appendix B. Simultaneous and individual loading events were observed throughout the test program (Table 1).
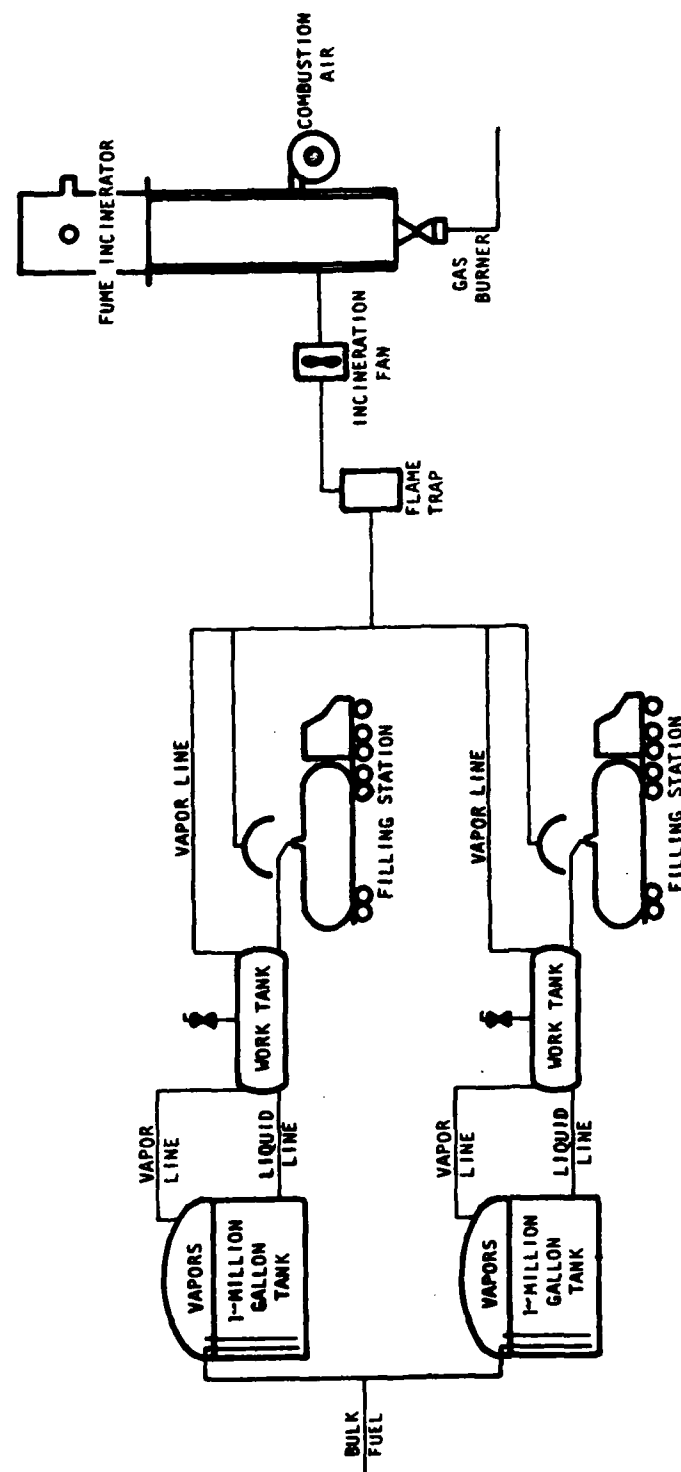
2

Figure 1. JP-4 Vapor Incineration System

SECTION 3

SAMPLING AND ANALYTICAL METHODS

STACK EXTENSION

The existing JP-4 incinerator stack had no sampling ports, and because of the presence of radial air injection tubes, which run the entire length of the stack interior, it was not feasible to install sampling ports. Therefore, it was necessary to design, fabricate, and install a stack extension with sampling ports to accommodate the testing requirements. Drawings of the stack extension are included in Appendix C. The extension was removed at the end of the project.

CONTINUOUS AND NONCONTINUOUS MONITORS

Hydrocarbons were analyzed using two gas chromatographs with flame ionization detectors (FIDS). One was continuous and measured total hydrocarbons (THC), while the other was manually operated and was used for hydrocarbon species analysis (C_1-C_6). This setup allowed for analysis of inlet and outlet vapor concentrations as well as performing cross checks between the two analyzers. Results of the hydrocarbon analysis are presented in Appendix B along with example strip charts of the hydrocarbon species analysis.

The THC analyzers' responses were recorded on strip charts for later data reduction. The gas chromatograph for species analysis recorded responses and calibrations on a strip chart and integrator (example in Appendix B).

Oxygen (O_2) was analyzed continuously with a Teledyne 320-AX O_2 monitor. The principle of detection is electro-catalytic cell response. The carbon monixode (CO) and carbon dioxide (CO_2) were analyzed by two nondispersive infrared analyzers (NDIR) made by Horiba instruments, model PIR-2000, and like O_2, were recorded on strip charts. Oxides of nitrogen (NO + NO_2 = NO_x) were measured using a TECO-10AR chemiluminescent analyzer and also recorded on a strip chart.

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All of the above mentioned analyzers were calibrated with certified gases prepared by competent analytical gas vendors. The calibration of each instrument includes a multipoint calibration to show linearity of the instrument and periodic zero and span checks to assure that the analyzer response does not drift beyond acceptable limits.

Further information on sample and analysis techniques can be found in The Code of Federal Regulations (40 CFR, Part 60, Appendix A, Reference Methods). EPA reference methods were used whenever applicable. The applicable methods are:

EPA reference method 20 - NO_x, O_2

EPA reference method 10 - CO, CO_2

EPA reference method 25a - THC

MEASUREMENTS

The volumetric flow rate of the incinerator exhaust was determined by using EPA reference methods 1 and 2. This method consists of sampling 12 points across two diameters of the stack and determining the pressure head (using S-type pitot tube) at each point. (See data in example calculations). The method also requires the ports to be a certain distance (based on stack diameter) away from any flow disturbance. This is the reason the stack extension was necessary. The radial air injection tubes (Appendix C) constituted obstruction of flow.

TEMPERATURE MEASUREMENT

Exhaust gas temperatures were measured using a k-type thermalcouple and digital temperature indicator (DTI). Temperatures were recorded (hand-written) along the CO_2 analyzer's trace. Temperatures varied depending on the cycle of the process. Temperatures ranged from 350°F during natural gas warmup to a maximum of 938°F during incineration of JP-4. The average stack temperature during loading events was 840°F.

POLLUTANT MEASUREMENT

Once the velocity was determined, the analyzers calibrated, and the incinerator in operation, a sample was drawn down a clean Teflon® sample

line to the analysis trailer. In the trailer, the gas was diverted to the continuous monitors and responses were recorded on strip charts. Analyses of the exhaust gases were continuous throughout the full events. Inlet samples were collected in Tedlar® bags and run immediately on the gas chromatograph in the trailer. A schematic drawing of the sampling trailer is found in Figure 2.
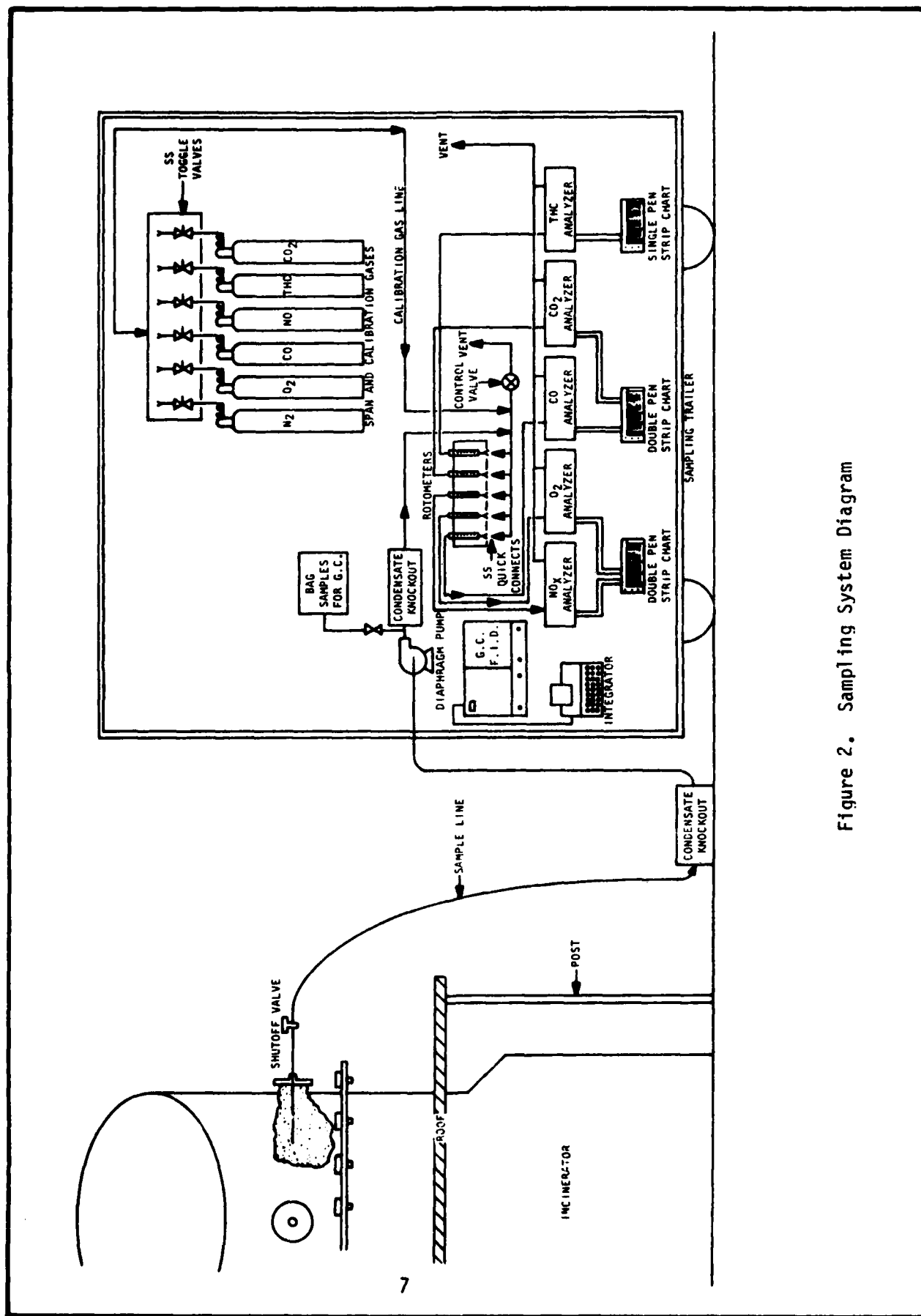
Figure 2. Sampling System Diagram

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SECTION 4

SUMMARY OF RESULTS

Table 1 of this report shows the eight loading events observed during this test program. Five of these events were the loading of trucks with JP-4 for refueling of jets. A description of the truck loading events are found in Table 2. The remaining events were bulk transfers of JP-4 from a large storage tank to two smaller working tanks.

Concentrations of NO_x, CO, CO_2, O_2 and hydrocarbons were determined by sampling the outlet stack of the incinerator during each event. The outlet concentrations are presented in Table 3. From these concentrations, percent combustion efficiency was calculated. The volumetric flow rate of the incinerator's exhaust gas was determined using EPA approved methods. From the concentration and velocity measurements, a mass emission rate of NO_x and CO (criteria pollutants) was calculated (Table 4). These emission rates indicate efficient operation of the process.

Inlet hydrocarbon concentrations were determined in order to calculate hydrocarbon destruction efficiencies. Due to the short duration of some events and mechanical malfunctions, three of the eight inlet samples were not considered to be viable data. Destruction efficiencies ranged from 95.9 percent to 99.5 percent (Table 5).

All of the above mentioned tests were conducted at Ellington AFB, Texas on June 2-3, 1982.

APPENDIX A

SAMPLE CALCULATIONS

APPENDIX A

EMISSION CALCULATIONS

I. MASS EMISSION RATES

The emissions are calculated as follows, using the field data from event #1 as an example.

Calculate the NO_x concentration in pounds per standard cubic feet:

$$C_{NO_x} = \text{ppm } NO_x \times 10^{-6} \times \frac{MWT}{385.1} \times \frac{\text{lb/lb mole}}{\text{scf/lb mole}} \text{ at } 528°R \text{ and } 29.92" \text{ Hg}$$

C_{NOx} = concentration NO_x, lb/scf

MWT = 0.8(30.0) + 0.2(46.0) = 33.2 lb/lb mole
(Based on 80% NO and 20% NO_2, normal for incinerators)

$$C_{NO_x} = 10\text{ppm} \times 10^{-6} \times \frac{33.2}{385.1} = 8.62 \times 10^{-7} \text{ lb/scf } NO_x$$

Calculate the exhaust flow:

$$ACFM = Vel \times 60 \times A_s$$

where: ACFM = Actual ft.^{3}/min

Vel = Velocity - ft/sec.

A_s = Stack area - ft.^{2}

$$DSCFH = ACFM \times 60 \times \frac{528}{Ts} \times \frac{Ps}{29.92} \times (1 - F_{H_2O})$$

where: DSCFH = Dry standard ft.^{3}/hr at 68°F and 1atm.

Ts = stack temperature, °R

Ps = stack pressure, Hg"

F_{H_2O} = moisture fraction

DSCFH = 594,000

$$E_{NO_x} = C_{NO_x} \times DSCFH = 8.62 \times 10^{-7} \times 594,000 = 0.51 \text{ lbs/hr}$$

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Calculate emissions of carbon monoxide:

$$C_{CO} = C_{CO\ Stack} \times \frac{28}{385.1} \times 10^6 = 23.5 \times \frac{28}{385} \times 10^6 = 1.71 \times 10^{-6}$$

$$E_{CO} = 1.71 \times 10^{-6} \times 594,000 = 1.02\ lbs/hr$$

II. COMBUSTION EFFICIENCY CALCULATION

$$\frac{[CO_2]}{[CO_2] + [CO] + [THC]} \times 100 = \%CE$$

EXAMPLE: Event #1:

$$\frac{18000\ ppm}{18000 \times 23.5 + 34.7} \times 100 = 99.67\%$$

III. DESTRUCTION EFFICIENCY CALCULATION:

$$1 - [\frac{Mass\ Hydrocarbon\ (exhaust)}{Mass\ Hydrocarbon\ (feed)}] \times 100 = \%DE$$

Example: Event #8:

$$1 - \frac{2.4\ g/min}{390\ g/min} \times 100 = 99.4\%\ DE$$

Velocity Calculations
PRELIMINARY
ORSAT ANALYSIS RESULTS

Date __June 3, 1982__

Time __9:30 am__

Gas   Fractional Part

CO_2	2.0%
O_2	17.4%
CO	0.0%
N_2	80.6

Orsat fractional parts must sum to 1.00.

At least one preliminary Orsat analysis must be taken unless reliable preliminary information is available from other sources. If a preliminary Orsat is not taken, state how this preliminary information was obtained: _____

_____

PRELIMINARY
MOLECULAR WEIGHT CALCULATIONS

This calculation of molecular weight is not required for gaseous sampling.

	Molecular Weights		Moisture Fraction	Partial Mol. Wt.
H_2O	18 . . . X . . .	[.1 / Dry	] =	1.8
		Orsat Fraction	Gas Fraction	
CO_2	44 X	.02	X	.8
O_2	32 X	.174	X .9	5.0
CO	28 X	0.0	X	0.0
N_2	28 X	.806	X	20.31

Molecular Weight of Stack Gas 27.91
(Sum of partial molecular weights)

PRELIMINARY VELOCITY DETERMINATION

Traverse Pt.	Δp (inches H2O) I	II	III
1	.020		
2	.010		
3	.012		
4	.012		
5	.010		
6	.015		
7	.020		
8	.012		
9	.015		
10	.010		
11	.012		
12	.015		
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

For Preliminary Velocity Calculation, Isokinetic Sampling

1. Use calculator to sum the square roots of all Δp's and divide this by N, the number of Δp's.

$$\text{Aver. } \sqrt{\Delta p} = \frac{\Sigma \sqrt{\Delta P}}{N}$$

$$\text{Aver. } \sqrt{\Delta p} = \frac{(1.388)}{(12)} = .116$$

(units are inches H_2O to the one half power)

2. Obtain the pitot tube calibration factor for the probe used. Probe No. 1 Pitot Tube Calibration Factor .84 (Shown in the equation below as PTCF)

3. Calculate Absolute Stack Pressure:
Measured Stk. Press.
(gage) 0.0 "H_2O
(Measured stack press. may be (+) or (-))

Preliminary Atmo. Press. 30.00 "Hg

Stack pressure in inches of water (gage), times 0.07355, plus the barometric pressure in inches mercury equal to the absolute stack pressure in inches of mercury:

(   )in.H_2O x 0.07355 + (   )in.Hg

= Stack Press. 30.00 in.Hg

4. Calculate average preliminary velocity, V, in feet per second as shown below.

$$V = 85.48 \times PTCF \times \sqrt{\frac{\text{Stack Temp. °R}}{\text{Mole. Wt.} \times \text{Stk. Press. inches Hg}}} \times \text{Average } \sqrt{\Delta p}$$

$$V = 85.48 \times (.84) \times \sqrt{\frac{(1300)}{(27.91) \times (30.00)}} \times (.116) = \underline{10.38} \text{ ft/sec}$$

4 ft

622.F ft/min
9,901.1 ft³/min
180,368 liters/min

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APPENDIX B

EXAMPLE STRIP CHARTS AND CALIBRATIONS

ESTERLINE INDIANAPOLIS

3 PM

2 PM

~8 oz Z

8

Direction of
pen movement

100

100

90

90

80

80

70

70

O$_2$ Calibration 0-25%
12.1% and 21.1% Standards

60

60

~12.1%

6 PM

4 PM

2 PM

50

50

50

40

40

40

30

30

30

21.0% O$_2$

20

20

20

10 AM

9 AM

8 AM

E on VO$_2$

10

10

10

16

6-3-82 Ellington AFB
JP-4 Incinerator Test
Operator: Rick Krenzke

NOx Calibration 0-100 ppm
3.7 & 17 ppm Standards

CO₂ Calibration 0-15%
5% Standard

CO Calibration 0-1000 ppm
252 ppm Standard

ESTERLINE ANGUS
INDIANAPOLIS, IND., U.S.A.

THC Calibration 0-500 ppm
159 ppm CH₄ Standard

3 June 82
Ellington AFB JP-4 Incinerator

159 ppm CH₄
1500 Range - C

8 PM

12 N
8 AM
7 AM
11 AM
10 AM

100
90
80
70
60
50
40
30
20
10
0

19

G.C. Calibration and Inlet Samples for Event #6

Event #6

6 PM

4 PM

2 PM

AM

1 AM

Switched to 0-5000 ppm range
Dilution of 1:160

20
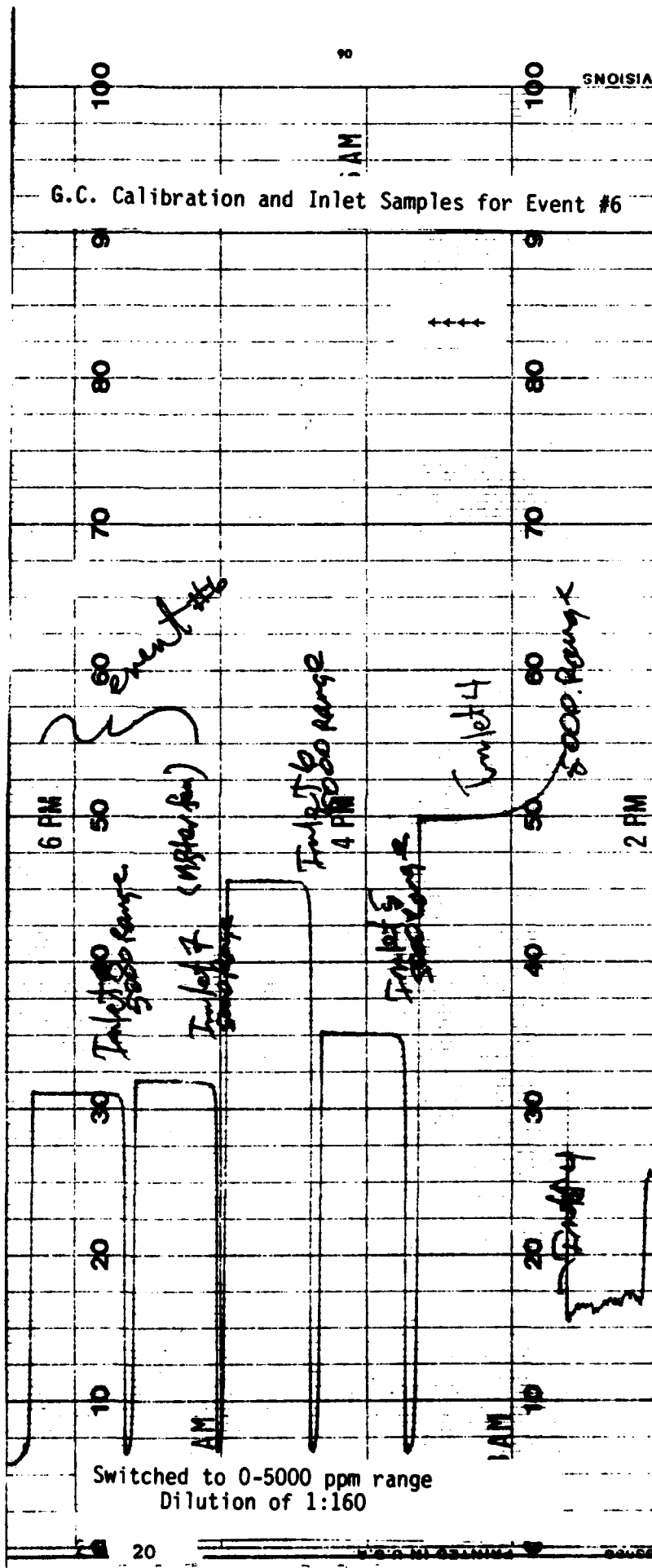
Example Strip Charts
NO$_x$/O$_2$ Strip Charts
NO$_x$ = 0-100 ppm by volume
O$_2$ = 0-25% by volume

Event #6

ESTERLINE ANGUS
INDIANAPOLIS IND. U.S.A.
CHART NO. 240514 - EQUAL DIVISIONS

11 AM   100   10 AM   100   9 AM

90   90   90

80   80   80

70   70   70

60   60   60

8 AM   6 AM 50   4 AM   50 2 AM

40   40

Event #6 (End)   Event #6 (Continued)

2:26 PM

NOx

4 AM   10 3 AM   2 AM 10   1 AM

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PLATE E3088
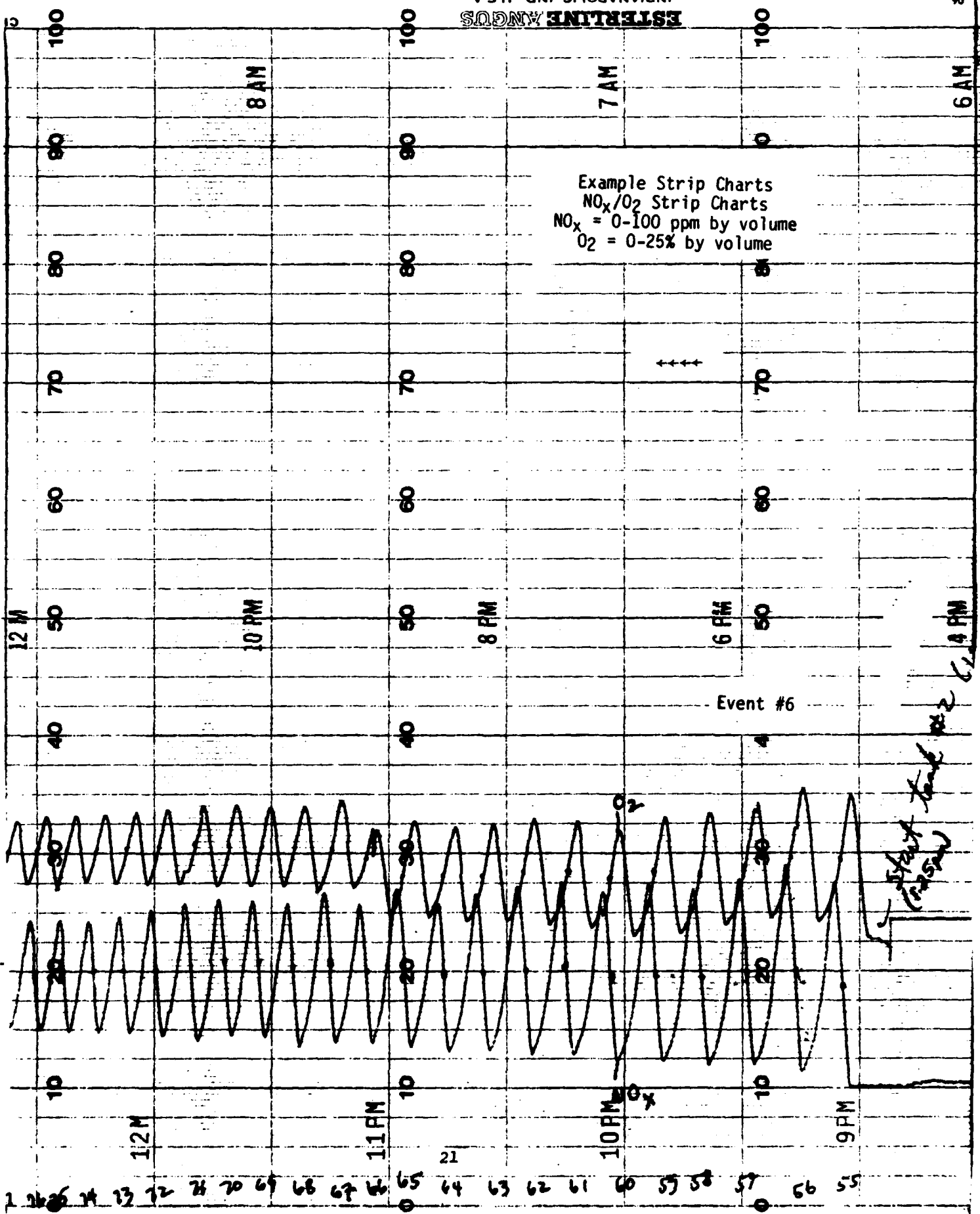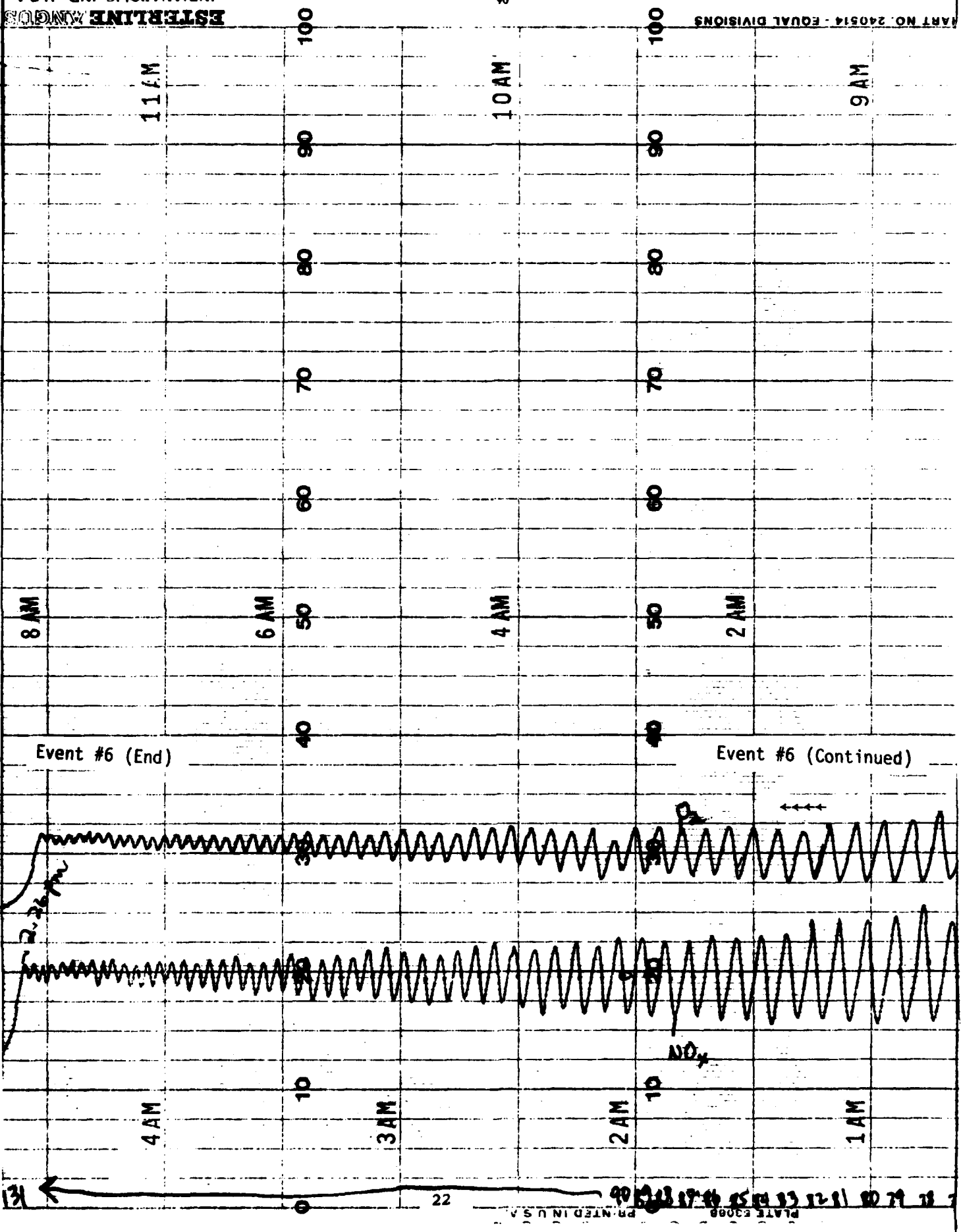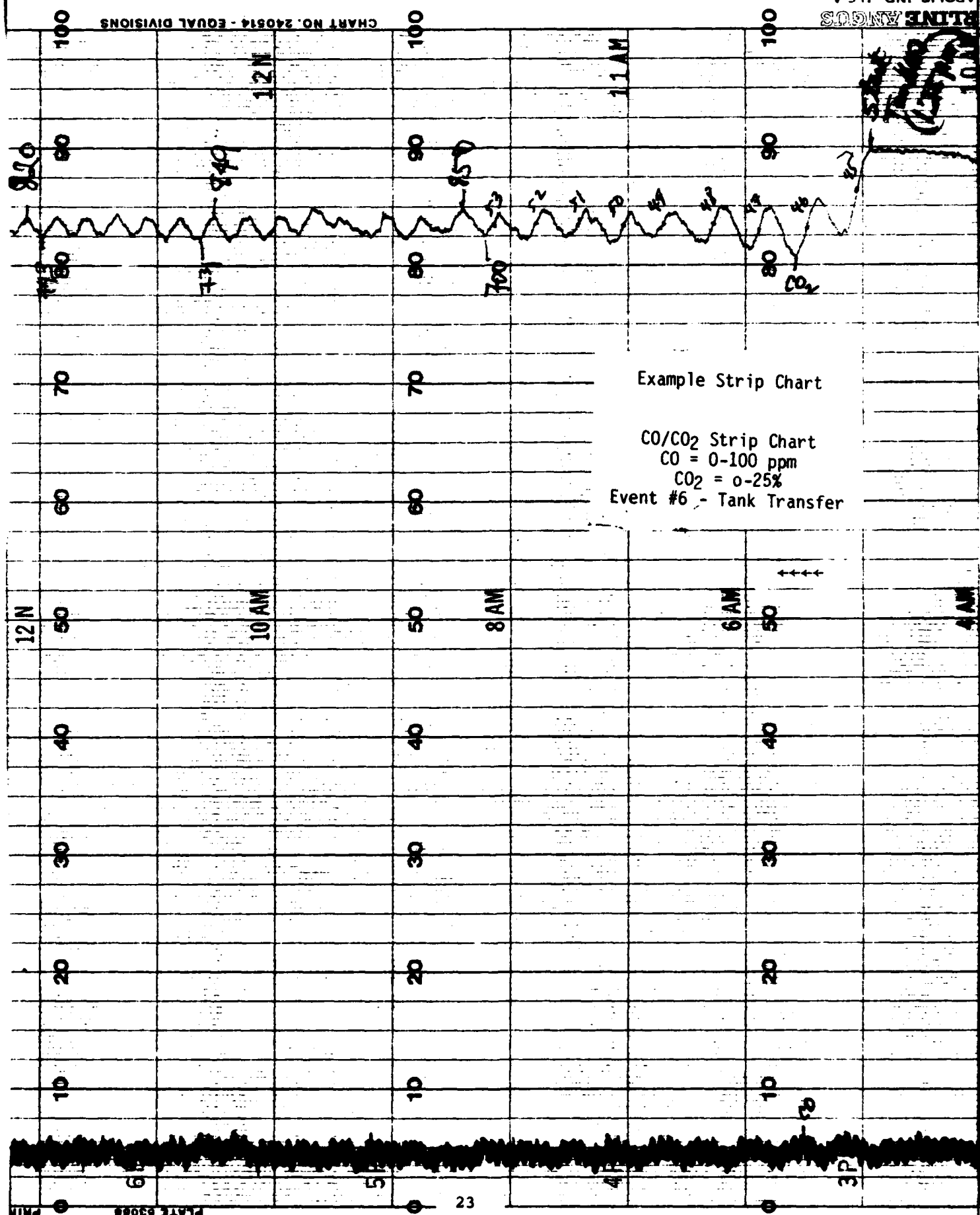
Example Strip Chart

CO/CO2 Strip Chart
CO = 0-100 ppm
CO_2 = o-25%
Event #6 - Tank Transfer

CO_2

12N

11AM

10AM

8AM

6AM

4AM

23

Event #6 (End)

Event #6 (Continued)

3 PM

2 PM

1 PM

6 PM

4 PM

2 PM

100

90

80

70

60

50

40

30

20

10

Example THC Strip Chart

THC 0-50 ppm
Event #6

Event #6 (End)
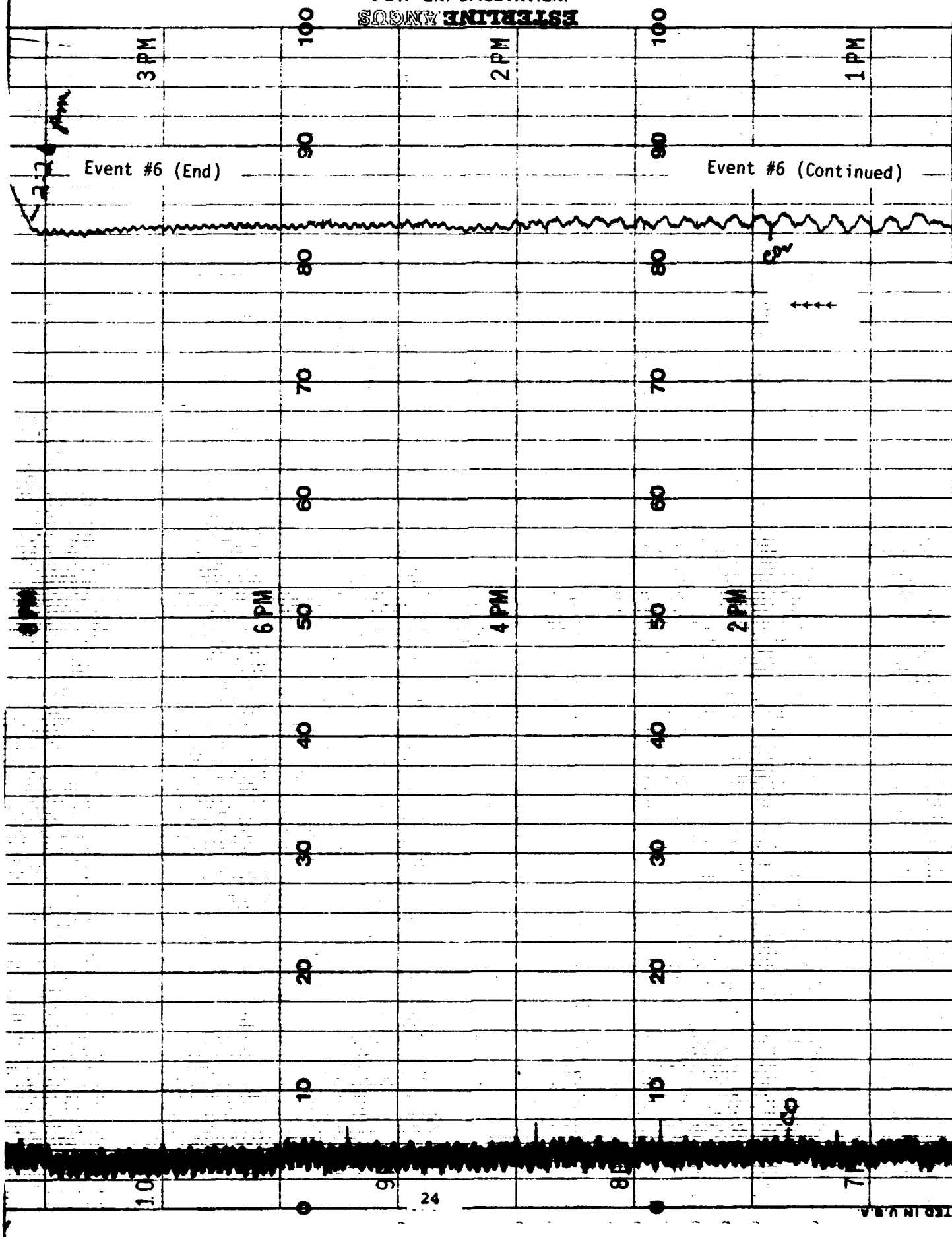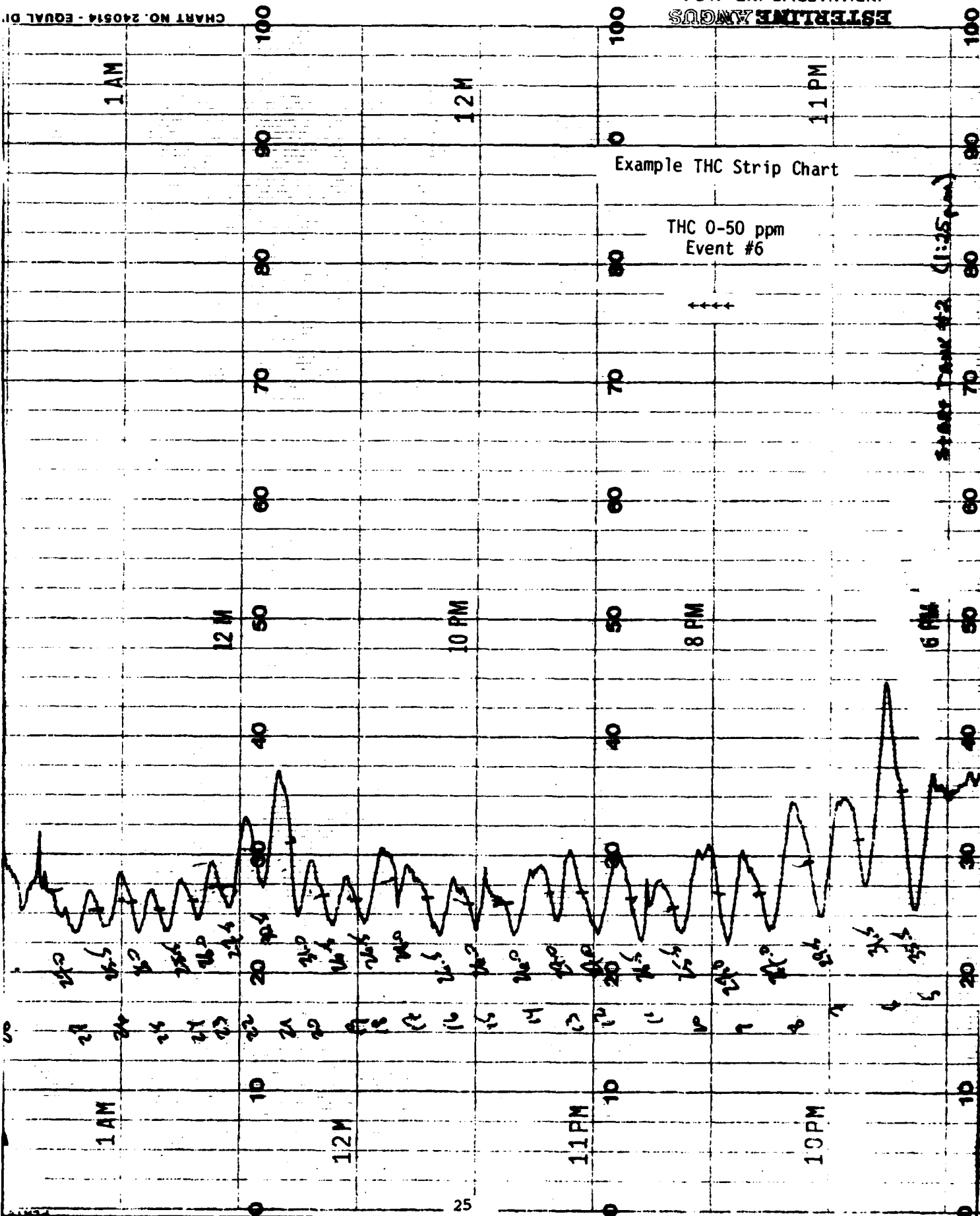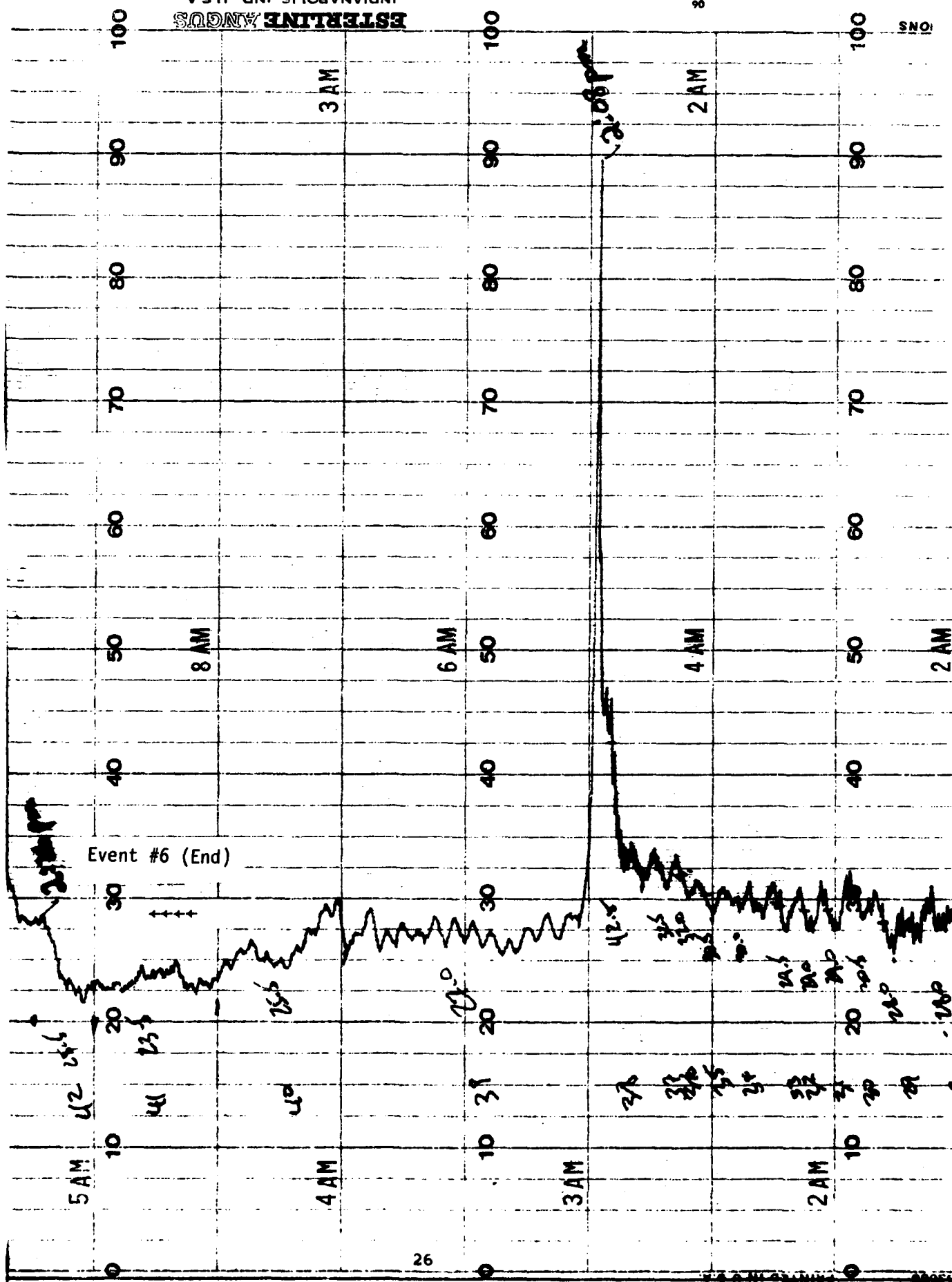
Example Strip Chart

DATE   2 JUN 82
TIME   1426

SAMPLE NO   43.
PROGRAM NO   1

NO	TIME	AREA HEIGHT	
1	1.27	525	
		82	
TOTAL		525	

DATE   2 JUN 82
TIME   1429

SAMPLE NO   44.
PROGRAM NO   1

NO	TIME	AREA HEIGHT	
1	1.27	558	BV
		85	
TOTAL		558	

DATE   2 JUN 82
TIME   1432

SAMPLE NO   45.
PROGRAM NO   1

NO	TIME	AREA HEIGHT	
1	1.27	631	BV
		88	
2	1.60	169	VB
		17	
TOTAL		800	

G.C. species analysis

Event #6

Outlet Samples   Outlet Samples   Outlet Samples   Outlet Samples   Outlet Samples   Outlet Samples   Outlet Samples

Species Analysis
Methane/Ethane Only

27

14

calibration for outlet samples

DATE   2 JUN 82
TIME   1439

SAMPLE NO   47.
PROGRAM NO   1

NO	TIME	AREA HEIGHT
1	1.26	4860
		874
2	2.41	5246
		586
TOTAL		10106

etyl/c3H8 Std

DATE   2 JUN 82
TIME   1442

SAMPLE NO   48.
PROGRAM NO   1

NO	TIME	AREA HEIGHT
1	1.26	4920
		888
2	2.41	5332
		587
TOTAL		10252

CH_4/C_3H_8 Standard

CH_4/C_3H_8 Standard

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Example G.C. Calibration
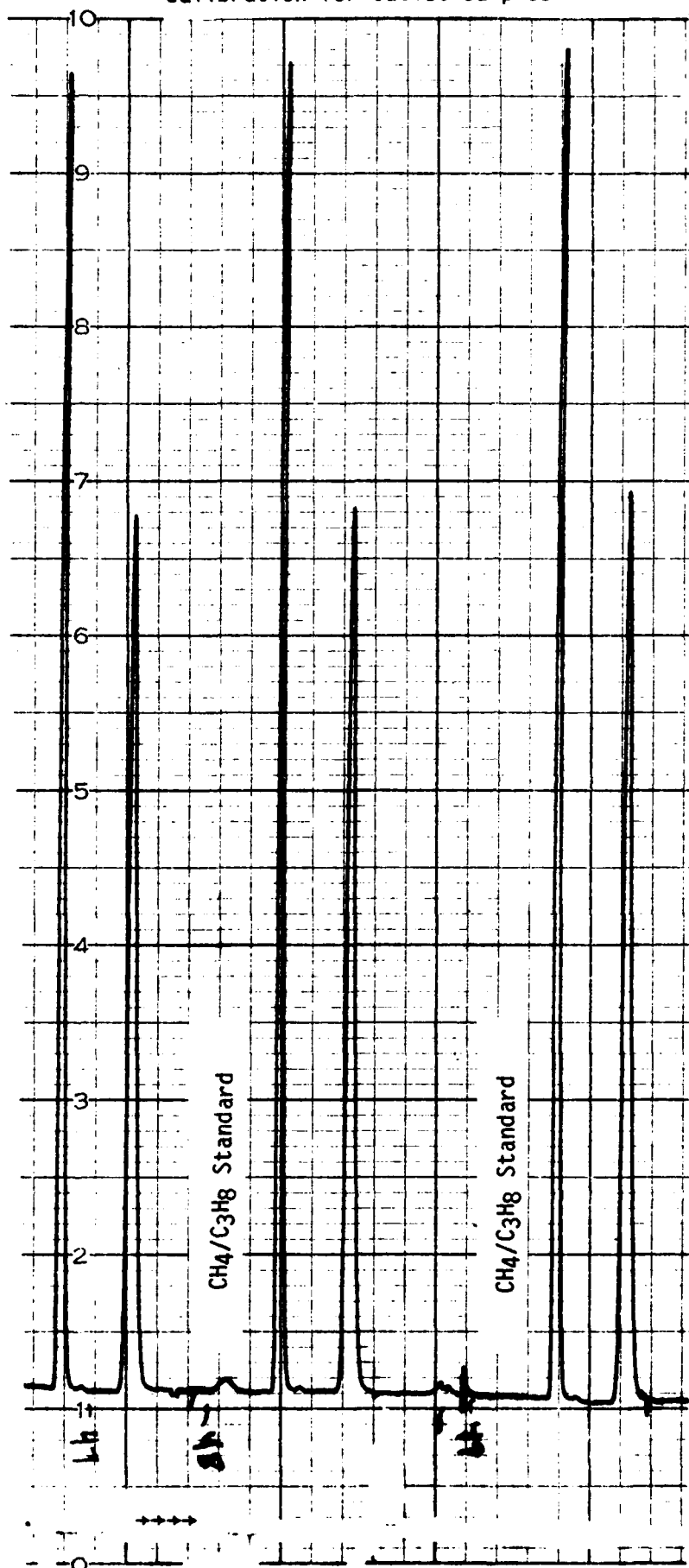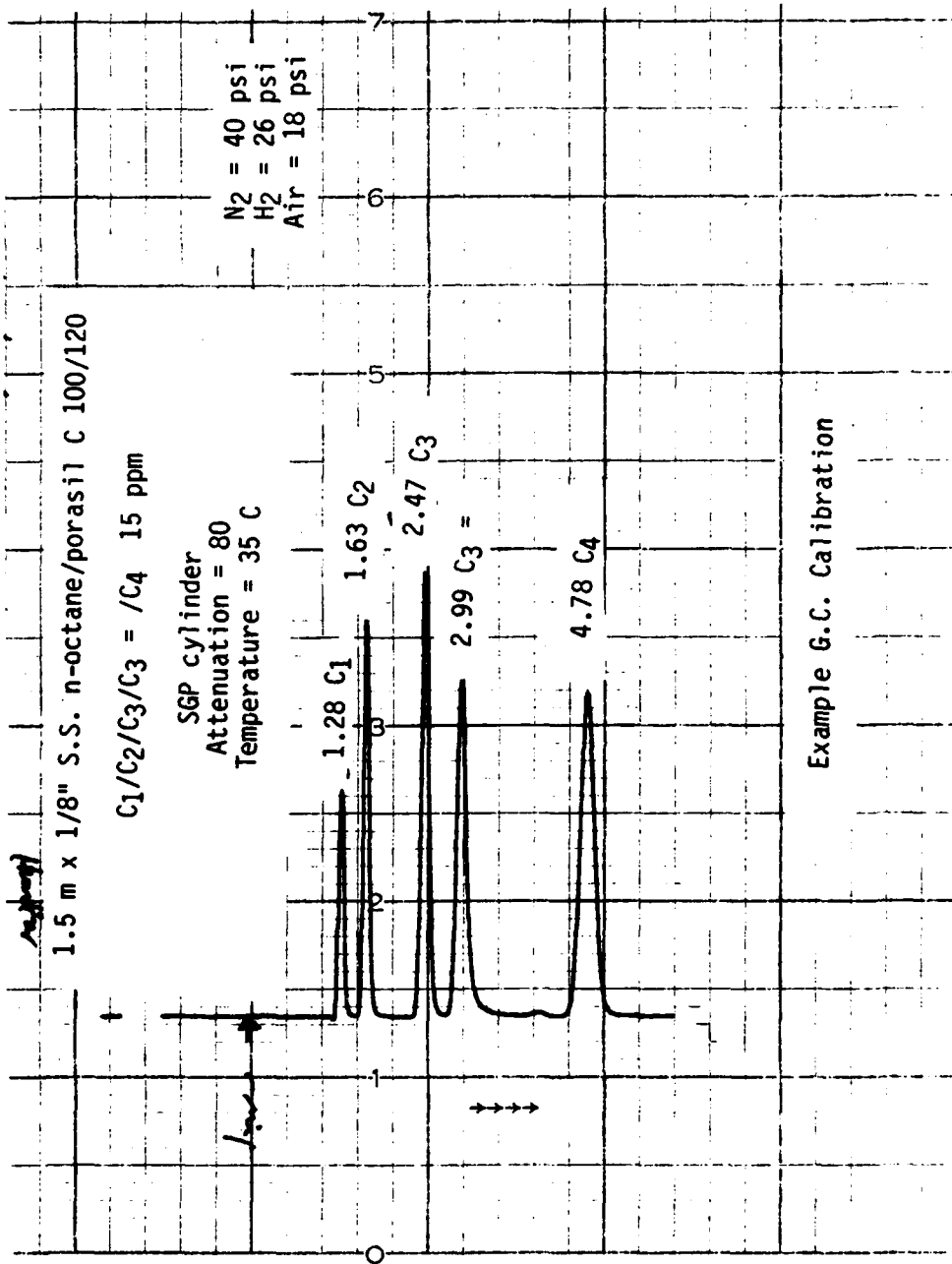
OmniScribe® CHART TYPE EC-100

29

CH₄/C₃H₈ Standard

Integration

```
DATE    29 MAY 82
TIME    1534

SAMPLE NO        0.
PROGRAM NO        1

RUN PARAM
INIT PK WDTH    0.1
MIN PK SIZE     0.0
SENSITIVITY      20.

NO    TIME    AREA
              HEIGHT
 1    1.28    1149
               207
 2    2.47    1236
               137
             -------
TOTAL         2385

CALC PARAM
TYPE CALC         0
```

Program

```
PROGRAM           1
RUN PARAM
INIT PK WDTH    0.1
MIN PK SIZE     0.0
SENSITIVITY      20.
CALC PARAM
TYPE CALC         0
TYPE RESULTS    DEFER
SYS FACTOR      DEFER
ISTD AMOUNT     DEFER
SAMPLE AMT      DEFER
MIN REPORT      DEFER
IDENT PARAM
CAL TABLE NO    DEFER
TIME REF PEAKS  DEFER
MIN VALUE       DEFER
PCT WINDOW      DEFER
MIN WINDOW      DEFER
UNK FACTOR      DEFER
CAL TBL PCT     UPDATE
NORMAL RUN      DEFER
CAL RUN         DEFER
```

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A. G.C. CONDITONS
B. G.C. SPECIES ANALYSIS
AND HYDROCARBON DATA

ELLINGTON AIR FORCE BASE

G.C. Conditons

Column: 1.5 m x 1/8" stainless steel n-octane/porasil C 100/120
Oven Temperature: 35°C
Sample Loop: 1 cc
Carrier Flow: 35 cc/min
Lower Detectable Limit: 0.1 ppm

INLET THC ANALYSIS

Date/Time	Sample #	Range	% Response	Dilution Ratio	ppm	Actual Conc.	Comment
JUNE 2, 1982							
	I-1B	5,000	21.8	1:160	1,095	174,000	Event #1
1212	I4	5,000	45.0	1:160	2,250	360,000	
1231	I5	5,000	30.0	1:160	1,500	240,000	Event #4
1252	I6	5,000	40.5	1:160	2,025	324,000	
1405	I7	5,000	26.8	1:160	1,340	214,400	Event #6
1406	I8	5,000	31.0	1:160	1,300	208,000	
JUNE 3, 1982							
0920	I10	5,000	46.0	1:160	2,300	368,000	Event #7
0930	I11	5,000	40.5	1:160	2,025	324,000	Event #8

OUTLET THC ANALYSIS

Time	Injection #	Range	% Chart	% Response	ppm	Comments
2 JUNE						
0802		50	21.0	16.0		Warmup
0803		50	Off scale	–		Warmup
0804	1	100	43.5	38.5	38.5	Load truck #1
	2	100	42.0	37.0	37.0	
	3	100	43.0	38.0	38.0	
	4	100	37.5	32.5	32.5	
	5	100	37.5	32.5	32.5	
	6	100	41.0	36.0	36.0	
	7	100	33.5	28.5	28.5	(Avg. = 34.7 ppm) Event 1
0820						End load #1
	1	100	38.0	33.0	33.0	Start Truck #2
	2	100	30.5	25.5	25.5	
	3	100	23.0	18.0	18.0	
	4	100	35.5	30.0	30.0	(Avg. = 26.6 ppm) Event 2
0836						End truck #2
	1	100	28.0	23.0	23.0	Start truck #3
	2	100	22.0	17.0	17.0	
	3	100	21.5	16.5	16.5	
	4	100	31.0	26.0	26.0	(Avg. = 20.6 ppm) Event 3
0849						End truck #3
1200						
1207		100				Warmup
1209	1	100	20.5	15.5	15.5	Start load
	2	100	22.0	17.0	17.0	
	3	100	20.5	15.5	15.5	
	4	100	20.0	15.0	15.0	
	5	100	19.0	14.0	14.0	
	6	100	19.5	14.5	14.5	
	7	100	19.0	14.0	14.5	
	8	100	19.5	14.5	14.5	
	9	100	20.0	15.0	15.0	
	10	100	19.5	14.5	14.5	
	11	100	17.5	12.5	12.5	
	12	100	18.0	13.0	13.0	
	13	100	18.0	13.0	13.0	
	14	100	19.0	14.0	14.0	
	15	100	19.5	14.5	14.5	
	16	100	16.0	11.0	11.0	
	17	100	16.5	11.5	11.5	
	18	100	16.0	11.0	11.0	
	19	100	17.5	12.5	12.5	
	20	100	16.5	11.5	11.5	
	21	100	16.5	11.5	11.5	

Time	Injection #	Range	% Chart	% Response	ppm	Comments
	22	100	20.5	15.5	15.5	
	23	100	17.0	12.0	12.0	
	24	100	15.5	10.5	10.5	
	25	100	18.0	13.0	13.0	
	26	100	17.0	12.0	12.0	
	27	100	18.0	13.0	13.0	(Avg. = 13.3 ppm) Event 4
1303	28	100	15.5	10.5	10.5	Both tanks filling (Avg. = 10.5 ppm) Event 5
1309						
1316	1	50	33.0	28.0	14.0	Tank #1 loading
	2	50	29.0	24.0	12.0	
	3	50	30.5	25.5	12.8	
1321	4	50	33.5	28.5	14.3	Tank #1 full
1325	5	50	35.5	30.5	15.3	Start tank #2
	6	50	31.5	26.5	13.3	
	7	50	29.5	24.5	12.3	
	8	50	27.0	22.0	11.0	
	9	50	27.0	22.0	11.0	
	10	50	25.5	20.5	10.3	
	11	50	26.5	21.5	10.8	
	12	50	27.0	22.0	11.0	
	13	50	27.0	22.0	11.0	
	14	50	26.0	21.0	10.5	
	15	50	26.0	21.0	10.5	
	16	50	26.5	21.5	10.5	
	17	50	28.0	23.0	11.5	
	18	50	26.5	21.5	10.8	
	19	50	26.5	21.5	10.8	
	20	50	31.0	26.0	13.0	
	21	50	30.5	25.5	12.5	
	22	50	27.5	22.5	11.3	
	23	50	26.0	21.0	10.5	
	24	50	25.5	20.5	10.3	
	25	50	26.0	21.0	10.5	
	26	50	25.5	20.5	10.3	
	27	50	27.0	22.0	11.0	
	28	50	28.0	23.0	11.5	
	29	50	28.0	23.0	11.5	
	30	50	30.5	25.5	12.8	
	31	50	29.0	24.0	12.0	
	32	50	29.0	24.0	12.0	
	33	50	29.5	24.5	12.3	
	34	50	30.0	25.5	12.8	
	35	50	30.5	25.5	12.8	
	36	50	32.0	27.0	13.5	
	37	50	32.5	27.5	13.8	
	38	50	42.5	37.5	18.8	
	39	50	27.0	22.5	11.3	
	40	50	25.5	20.5	10.3	

Time	Injection #	Range	% Chart	% Response	ppm	Comments
	41	50	23.5	18.5	9.3	(Avg = 11.9 ppm) Event 6
1426	42	50	25.5	20.5	10.3	End fill
3 JUNE						
0807		50				Warmup
0809	1	50	20.5	15.5	7.8	Start Load #1 (two trucks)
	2	50	38.0	33.0	16.5	
	3	50	44.0	39.0	19.5	
	4	50	45.0	40.0	20.0	
	5	50	51.0	46.0	23.0	
	6	50	44.5	39.0	19.5	
	7	50	44.0	39.0	19.5	
	8	50	42.0	37.0	18.5	
	9	50	41.5	36.5	18.3	
	10	50	43.0	38.0	19.0	
	11	50	42.5	37.5	18.8	
	12	50	35.0	30.0	15.0	
	13	50	41.0	36.0	18.0	
	14	50	40.0	35.0	17.5	
	15	50	40.5	35.5	17.8	
	16	50	39.0	34.0	17.0	
	17	50	38.0	33.0	16.5	
	18	50	36.5	31.5	15.8	
	19	50	36.5	31.5	15.8	
	20	50	35.0	30.0	15.0	
	21	50	33.0	28.0	14.0	
	22	50	33.0	28.0	14.0	
	23	50	34.5	29.5	14.8	
	24	50	34.5	29.5	14.8	
	25	50	34.5	29.5	14.8	
	26	50	34.0	29.0	14.5	
	27	50	31.0	26.0	13.0	
0827	28	50	35.0	30.0	15.0	Finish loading one truck
0827	29	50	34.5	29.5	14.8	Load one truck
	30	50	35.0	30.0	15.0	
	31	50	36.5	31.5	15.8	
	32	50	36.0	31.0	15.5	
	33	50	35.5	30.5	15.3	
	34	50	37.0	32.0	16.0	
	35	50	35.5	30.5	15.3	
	36	50	36.0	31.0	15.5	
	37	50	35.0	30.0	15.0	
	38	50	38.0	33.0	16.5	
	39	50	47.0	42.0	21.0	(Avg = 16.4 ppm) Event 7
0839	40	50	56.5	51.5	25.8	Start load #2 (two trucks)

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Time	Injection #	Range	% Chart	% Response	ppm	Comments
	41	50	45.0	40.0	20.0	
	42	50	33.0	28.0	16.0	
	43	50	29.5	24.5	12.3	
	44	50	30.0	25.0	12.5	
	45	50	29.5	24.5	12.3	
	46	50	26.0	21.0	10.5	
	47	50	25.0	20.0	10.0	
	48	50	28.5	23.5	11.8	
	49	50	25.0	20.0	10.0	
	50	50	25.5	20.5	10.3	
	51	50	24.0	19.0	9.5	
	52	50	26.0	21.0	11.5	
	53	50	29.0	24.0	12.0	
	54	50	28.5	23.5	11.8	
	55	50	28.0	23.0	11.5	
	56	50	28.5	23.5	11.8	
	57	50	25.5	20.5	10.3	
0853	58	50	28.0	23.0	11.5	End loading of one truck
	59	50	28.0	23.0	11.5	
	60	50	26.5	21.5	10.8	
	61	50	29.5	24.5	12.3	
	62	50	30.0	25.0	12.5	
	63	50	30.0	25.0	12.5	
	64	50	32.5	27.5	13.6	
	65	50	34.0	29.0	14.5	
	66	50	32.5	27.5	13.8	
	67	50	31.5	26.5	13.3	(Avg = 12.7 ppm) Event 8
0859	68	50	30.5	25.5	12.8	End loading #2

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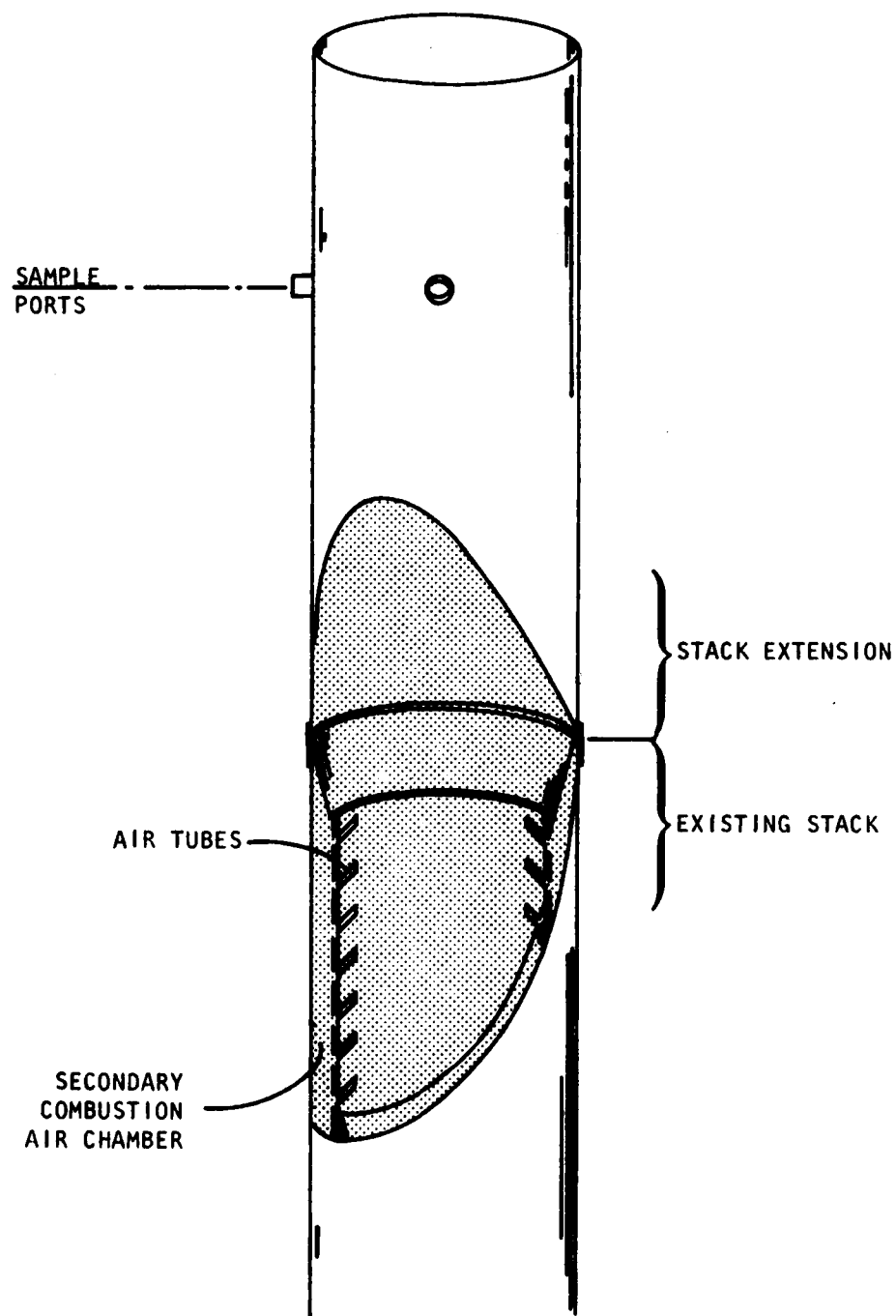
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APPENDIX C

STACK EXTENSION DRAWINGS

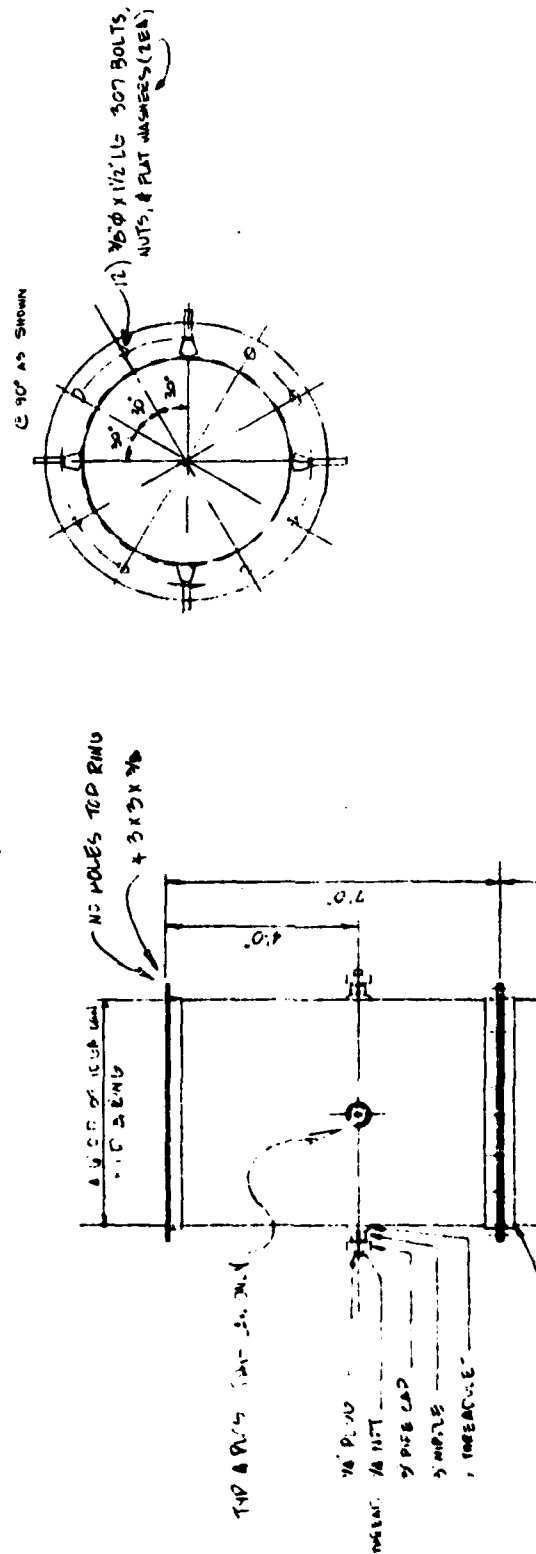Figure 3. Dimensional Specifications for Required Stack Extension

Figure 4. Engineering Drawings of Stack Extension.

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END